NORTHERN ROACH
Lavinia mitrulus (Snyder)

Status: High Concern. This species is restricted to a few isolated populations in California which could decline rapidly and face extirpation as result of alterations to streams, invasion of alien fishes, water withdrawal for agriculture and predicted impacts from climate change.

Description: Northern roach are small (adult size typically 50-100 mm), bronzy cyprinids. They have a robust body, deep caudal peduncle, short snout and short rounded fins. They are dark on the upper half of the body, light below, and very similar in appearance to the Central California roach. Northern roach differ from Central California roach in having short rounded fins and "cup-like" scales (see Snyder 1913 for more detail on scale morphology). Snyder (1908a) published morphometric data on 20 fish from Drews Creek (Lake County, Oregon), among them the type specimen of the species; all individuals had 8 dorsal rays and 7 fin rays. Snyder found that male roach had longer, larger fins than did females, especially pectoral fins; he also found that the sexes could be differentiated by the ratio of pectoral fin length to body length. These differences in the relative fin length between the sexes led Snyder to publish one of the first accounts of general sexual dimorphism in cyprinid fishes.

See the Central California roach account in this report for a more in-depth description of general roach morphology.

Taxonomic Relationships: Northern roach were first collected in 1898 by C. Rutter (1908), who recognized them as *Rutilus symmetricus* (Baird and Girard 1854a). Speaking of the specimens collected on this trip, Rutter (1908 p. 139) said *"We have but few small specimens of this form, the longest being but 3 inches long. They were taken in North Fork Pitt (sic) River near Alturas and at the mouth of Joseph Creek, several hundred miles from where any other specimens of* symmetricus *have been taken. The form may prove to not to be* symmetricus*, but we can not identify it otherwise with the material at hand."*

In 1904, John O. Snyder surveyed broadly in northeastern California and southeastern Oregon, collecting in the upper Pit River, along with the Goose Lake, Summer, Abert, Harney and Warner basins of Oregon but found roach only in the tributaries to Goose Lake, Lake County, Oregon (Snyder 1908a). Snyder (1913) erected a new genus, *Hesperoluecus,* and described six new species based on locality, isolation and morphological differences. Among the new species was the northern roach, *Hesperoleucus mitrulus,* from Drews, Muddy, and Cottonwood creeks, Lake County, Oregon. Snyder also reported that the species had not been recorded from Goose Lake itself or from the high-gradient Californian streams that flow into the lake from the Warner Mountains to the east. There is no indication that he was aware of the previous collection of roach in the Pit River by Rutter.

Northern roach were classified as a distinct species of *Hesperoleucus* by subsequent workers (Evermann and Clark 1931, Shapovalov and Dill 1950, Shapovalov et al. 1959), but Miller (1945a p. 197) suggested the "Preliminary analysis of the forms of *Hesperoleucus* shows that many if not all, of those described as species are geographic subspecies of *H. symmetricus*." Murphy (1948c), in an unpublished master's thesis, proposed that all coastal forms be demoted to subspecific status and submerged into *H. symmetricus*. Murphy (1948c) did not study samples of the northern roach, nor did he suggest that his subspecific diagnosis should be applied to *H. mitrulus*. However, it appears that when Murphy's (1948c) subspecific diagnosis for *H. parvipinnis, H. navarroensis, H. venustus and H. subtitus* was adopted by subsequent workers (Hopkirk 1973, Moyle 1976, Hubbs et al. 1979), subspecies status was erroneously applied to *H. mitrulus* as well. For a thorough discussion of the debate over the specific status of all roach forms, see the Central California roach account in this report.

The first inclusion of roach from the Pit River in *mitrulus* was by Hubbs et al. (1979 p. 11), who used the common name "upper Pit roach" when referring to *H. mitrulus*. While no mention is made of a range extension for the taxon, it is assumed that this change was precipitated by the 1934 collection of 19 roach in the North Fork Pit River near Alturas, Modoc County (unpublished field notes and collections of Carl Hubbs at the University of Michigan, as reported in Reid et al. 2003). The California Department of Fish and Wildlife (Shapovalov et al. 1981) subsequently applied the common name "upper Pit" roach to *H. symmetricus* but, like Hubbs et al. (1979), did not publish distributional information. Moyle et al. (1995) and Moyle (2002), list the "Pit" roach (i.e. *mitrulus)* as being native to the upper Pit River system, as well as to Oregon tributaries of Goose Lake.

Northern roach are reciprocally monophyletic for mtDNA haplotypes and show strong differentiation from all other roach populations based on nuclear microsatellites (Aguilar et al. 2009). Based on mtDNA sequence diversion, Aguilar et al. (2009) estimate that the northern populations of roach have been isolated for 8 million years.

In light of: (1) the recent genetic analysis (nuclear and mtDNA) that corroborates the distinctiveness of northern roach as described by Snyder (1913); and (2) the fact that Snyder's original species were never properly submerged (i.e. through formal publication of an analysis in the peer-reviewed literature), the northern roach is a valid full species. The subspecies name, *Lavinia s. mitrulus* (Hopkirk 1973) is pre-occupied by *Lavinia mitrulus* (Snyder 1913). Many variations of the common name "upper Pit" or "Pit River" have been applied to *mitrulus*; however, because the range consists of multiple isolated basins and because the type locality is in Lake County, Oregon, Snyder's original name for the taxon, "northern roach," seems most fitting.

Life History: Northern roach presumably share much of their life history with Central California roach but the specific life history attributes of northern roach have not been studied so cannot be verified.

Habitat Requirements: Northern roach tend to be associated with spring pools and swampy stream reaches, habitats dissimilar from those occupied by roach in the rest of California (S. Reid, pers. comm. 2009). Thus, in Ash and Rush creeks, Lassen and Modoc counties, roach are found in small numbers inhabiting the weedy margins of streams and, in one case, an isolated spring pond (Moyle and Daniels 1982, S. Reid, pers. comm. 2009). They do not often occupy intermittent streams in the Pit system, as is usual with roach in the rest of their range. Instead, speckled dace (*Rhinichthys osculus*) dominate these habitats.

Moyle and Daniels (1982) found that 94% of the fish species that co-occurred with northern roach were also native. The most common associates were speckled dace, Sacramento sucker (*Catostomus occidentalis*) and Pit sculpin (*Cottus pitensis*). The fact that roach occur as part of a predominately native fish assemblage has been observed elsewhere (Moyle and Nichols 1973, Leidy 1984, Brown and Moyle 1993, Leidy 2007). Moyle (2002) attributes the uncommon co-occurrence of roach with alien species to the tendency for roach to be easily displaced by invasive fish species, especially centrarchids.

Distribution: In California, northern roach are restricted to several tributaries of the upper Pit River. It is likely that they once inhabited the meandering valley floor reaches of the Pit River in Big Valley, Modoc County, but this area is now completely dominated by alien species (Moyle and Daniels 1982). Roach have not been recorded from Goose Lake itself or from the high-gradient Californian streams that flow into the lake from the Warner Mountains to the east. However, roach found in the northern tributaries of Goose Lake in Lake County, Oregon are also included in *H. mitrulus*. In a recent comprehensive sampling of the Oregon portion of the Goose Lake watershed, the Oregon Department of Fish and Wildlife (ODFW) found northern roach to be widespread and relatively abundant (>80 fish/km) in Dry, Drews, Hay, Dent, Muddy and Augur creeks (Heck et al. 2008).

Roach populations in the terminal lake basins adjacent to Goose Lake, in the high desert of eastern Oregon, may also belong to this species but distributional records are spotty and taxonomic relationships among these populations remain uncertain.

Pit River Falls, located five miles downstream of the town of Fall River Mills, Shasta County, divides the Pit River basin into upper and lower drainages. The falls are, at least partially, a barrier to fish movement. Historically, they represented the northern range limit for some Sacramento River basin fishes, such as tule perch, *Hysterocarpus traski* (Moyle 2002). Only roach found above Pit River Falls are considered northern roach, *L. mitrulus*. Roach found below the falls would have historically had unimpeded access to Sacramento River system and are assumed to be *L. s. symmetricus*. However, genetic studies have not been conducted and relationships remain uncertain.

Historical collecting trips to the upper Pit River system captured only a few specimens (Rutter 1908, Hubbs et al. 1934, from field notes and collections at the University of Michigan, as reported in Reid et al. 2003) or none at all (Snyder 1908a). In the most comprehensive sampling of the Pit system to date, Moyle and Daniels (1982) found roach at only 8% of 261 collection sites. Above Pit River Falls, roach were found in three drainages: (1) Ash–Rush–Willow Creek drainage, Lassen and Modoc counties, (2) Bear Creek, tributary to the Fall River, Shasta County and (3) Beaver Creek, Lassen County.

Trends in Abundance: Historically, roach were probably much more widely distributed in the upper Pit River drainage (e.g., Big Valley) but modern surveys have found that they have disappeared from reaches in which they previously occurred (reviewed in Reid et al. 2003). Reid et al. (2003), in the only known survey of the Upper Pit drainage since 1978, surveyed 12 sites in the North Fork, South Fork and upper mainstem Pit River (between Alturas and Rose Canyon) without collecting roach. The following is a history of roach occurrence in the upper Pit River basin:

North Fork Pit River. Rutter (1908), collecting in 1898, captured "a few small specimens" of roach. Snyder (1908), collecting in 1904 near the same location, did not capture any roach, while Hubbs and others collecting in the North Fork near Alturas in 1934 captured only 19 (from field notes and collections at the University of Michigan, as reported in Reid et al. 2003). Subsequent collectors have found green sunfish but not roach (Moyle and Daniels 1982, Reid et al. 2003).

South Fork Pit River. Three historic sampling trips found roach in the South Fork. Modern collecting trips have failed to document roach in the South Fork (from information in Reid et al. 2003).

Mainstem Pit River, Alturas to Pit River Falls. The only known record of capture is a single specimen taken by R.R. Miller in 1961 (from University of Michigan field notes and collections, as reported in Reid et al. 2003). This is the reach flowing through Big Valley which has been highly altered and contains mainly alien species (Moyle and Daniels 1982). However, roach remain common in the Ash Creek drainage (S. Reid. pers. com. 2009).

Nature and Degree of Threats: Factors which limit the abundance and distribution of northern roach are: (1) agriculture, (2) grazing, (3) logging, (4) transportation, (5) fire, (6) and alien species. These impacts are not necessarily listed in order of importance and do not operate independently but, instead, must be viewed in aggregate, along with other less pressing threats (Table 1), as cumulative and synergistic watershed impacts.

Agriculture. Agricultural alteration of the Pit River basin has a long history. The earliest fish survey of the region (1898) already described the South Fork Pit as being "almost drained by irrigation ditches" (Rutter 1908, p. 110). The low gradient areas favored by roach are also areas in which extensive pasture, hay, and other types of farming occur. For example, much of Big Valley, through which the Pit River flows, is devoted to growing alfalfa, pasture, and potatoes. It is likely that the river in this region was once habitat for roach but agricultural alteration, combined with abundant alien species, has made it unsuitable habitat. Many tributary streams in this region are channelized to reduce spring flooding of pasture and agricultural lands, a practice which eliminates roach habitat (Moyle 1976). The relationship between water withdrawal for irrigation and stream flow is not documented in the region, but Pit River flows are low and polluted with agricultural return water between Alturas and Fall River Mills, as evidenced by the Pit River being listed as impaired by high temperature, nutrients and low dissolved oxygen content under The Clean Water Act section 303(d) (U.S. EPA 2006).

	Rating	Explanation
Major dams	n/a	No major dams in the upper Pit drainage; however, there are numerous small dams and diversions
Agriculture	Medium	Diversions and return water have altered hydrology and water quality; channels have been altered
Grazing	Medium	Most streams have been heavily grazed
Rural Residential	Low	Residential water withdrawal may cause decreased summer flows in many small streams
Urbanization	Low	Urban areas occupy only a small portion of the watershed
Instream mining	Low	Limited; effects unknown
Mining	n/a	No known threats from mining at present
Transportation	Medium	Much of the river is bordered by roads; logging and ranch roads contribute to siltation, channelization, and habitat loss
Logging	Medium	Logging is a major land use in higher elevation parts of the watershed
Fire	Medium	Fires may cause local extirpation, especially in upper watersheds occupied by isolated populations
Estuary alteration	n/a	
Recreation	Low	Recreation results in little direct threat except through off road vehicle use and similar activities
Harvest	n/a	
Hatcheries	n/a	
Alien species	High	Intolerant of introduced predatory fish, especially centrarchids such as green sunfish

Table 1. Major anthropogenic factors limiting, or potentially limiting, viability of populations of northern roach in California. Factors were rated on a five-level ordinal scale where a factor rated “critical” could push a species to extinction in 3 generations or 10 years, whichever is less; a factor rated “high” could push the species to extinction in 10 generations or 50 years whichever is less; a factor rated “medium” is unlikely to drive a species to extinction by itself but contributes to increased extinction risk; a factor rated “low” may reduce populations but extinction is unlikely as a result. A factor rated “n/a” has no known negative impact. Certainty of these judgments is moderate. See methods section for descriptions of the factors and explanation of the rating protocol.

Grazing. Livestock grazing is pervasive in the Pit River watershed. Grazing impacts to streams can include: removal of riparian vegetation, stream bank collapse, sedimentation of pools, impaired water quality from sedimentation and animal waste input, and reduction in the amount of cover and shading. If grazing impacts to streams are severe, roach tend to disappear despite their high tolerance of adverse conditions. Stock ponds, which are created to provide water for cattle, can divert water from streams and support populations of non-native predatory fishes in the upper portions of watersheds (e.g. Ash Creek). These fish (e.g. green sunfish, largemouth bass) may colonize adjacent streams during wet periods when ponds spill and become hydrologically connected to streams, potentially eliminating roach populations.

Transportation. Streambeds with adjacent roads and road crossings are subject to fragmentation (where road crossings create barriers to fish movement) and increased sediment and pollutant input, degrading aquatic habitat quality and quantity for roach and other fishes. Roach populations decline when severe channelization of small streams occurs.

Logging. Most of the Pit River watershed that is not devoted to agriculture is covered with dry forestland, which is logged and grazed. Logging in the arid Pit drainage likely contributes sediments to streams, especially considering the nature of the volcanic soils across the region and wide use of highly friable crushed cinders for road base.

Fire. Fire is a natural part of the high desert landscape in the Pit River watershed. However, fires are likely more frequent and severe than they were historically because of human land management practices and associated changes to the landscape (especially fire prevention and consequent shifts in forest vegetation composition and density). Coupled with predicted climate change effects, more severe wildfires may eliminate roach habitats or possibly extirpate small populations from tributary streams.

Alien species. Roach cannot coexist with large populations of alien fishes, especially centrarchids such as green sunfish (*Lepomis cyanellus*) and largemouth bass (*Micropterus* spp.). Green sunfish, largemouth bass and bluegill are found together and often dominate the fish biomass in warm, slow, turbid reaches of the mainstem Pit River (Moyle and Daniels 1982). These stretches of river are now dispersal barriers to roach, further isolating small populations in tributary steams. Roach populations in refuge tributary watersheds are also threatened by escape of alien fishes from stock ponds (treated above under grazing), located higher in these watersheds.

Effects of Climate Change: Northern roach are well adapted to the warm, arid conditions of northeastern California. However, their dependence upon spring pools in late summer and swampy headwaters suggests that they are also particularly susceptible to decreases in base flows. While their ability to persist in small bodies of water bodes well for roach in a future of dwindling in-stream water supplies, it also suggests that they are likely to be extirpated from watersheds with streams that dry completely under the dual strains of increasing aridity associated with climate change and increasing local surface water diversions and ground water withdrawal for rural residential homes and agricultural irrigation. Because of their dependence on small streams in an arid region and the isolation of populations from one another, Moyle et al. (2013) rated northern roach as “critically vulnerable” to climate change.

Status Determination Score = 2.9 - High Concern (see Methods section Table 2). Although northern roach do not appear in immediate danger of extinction, populations are likely to decline and become extirpated from many areas as the result of alterations to streams, introduction of alien fishes and water withdrawal for agriculture, in combination with changes in climate. Existing fragmentation of populations makes re-colonization of streams from which they have been extirpated unlikely. The northern roach (as Pit roach) is listed by the American Fisheries Society as “Vulnerable” (Jelks et al. 2008) and by NatureServe as “G5T2, Imperiled” and by the Oregon Department of Fish and Wildlife as “Sensitive- Peripheral”.

Metric	Score	Justification
Area occupied	2	California range confined to widely separated tributaries of the upper Pit River
Estimated adult abundance	4	Localized populations may be substantial but populations are isolated and survey data are lacking
Intervention dependence	3	Annual monitoring and protection of most populations is needed
Tolerance	5	Remarkably resilient fish but preferred habitat in system is greatly reduced and fragmented
Genetic risk	3	Uncertain genetic relationships between small populations; effects of isolation likely
Climate change	1	Highly vulnerable in combination with watershed changes
Anthropogenic threats	2	See Table 1
Average	2.9	20/7
Certainty (1-4)	2	Relatively little recent information

Table 2. Metrics for determining the status of northern roach, where 1 is a major negative factor contributing to status, 5 is a factor with no or positive effects on status, and 2-4 are intermediate values. See methods section for further explanation.

Management Recommendations: A thorough fish population and habitat survey of the Pit River watershed should be performed in order to determine abundance and distribution of native fish populations, including roach, and habitat attributes of both occupied and unoccupied streams (or reaches thereof). Once baseline data are collected, basin-wide monitoring every five years should be established to determine status and trends of native fish populations and their habitats, as well as to detect alien fish invasions. An educational program should be developed for watershed residents, especially agricultural water users, to encourage water conservation measures and cooperative ventures to restore watershed functions in ways that benefit native fish. Consideration should be given toward establishing one or more streams as protected areas for California roach and other native fishes (e.g. Ash Creek). Some protection for northern roach is provided by its co-occurrence in a few streams with Modoc sucker (*Catostomus microps*), which is listed as a threatened species.

The water quality standards recommended by state and federal agencies should be adopted and vigorously enforced, including finding ways to reduce sediment loads (e.g., reducing the impact of roads of all types). Water rights in the entire watershed need to be adjudicated and a minimum flow provided for all streams to provide suitable year-round habitat for native fishes.

A comprehensive genetic investigation of Pit River basin fishes should be implemented, including roach (*Lavinia* species), tui chub (*Siphateles* species) and suckers (*Catostomus* species), in order to clarify taxonomic confusions about the relationship(s) between populations from isolated portions of Oregon and California and to better inform future management and conservation actions.

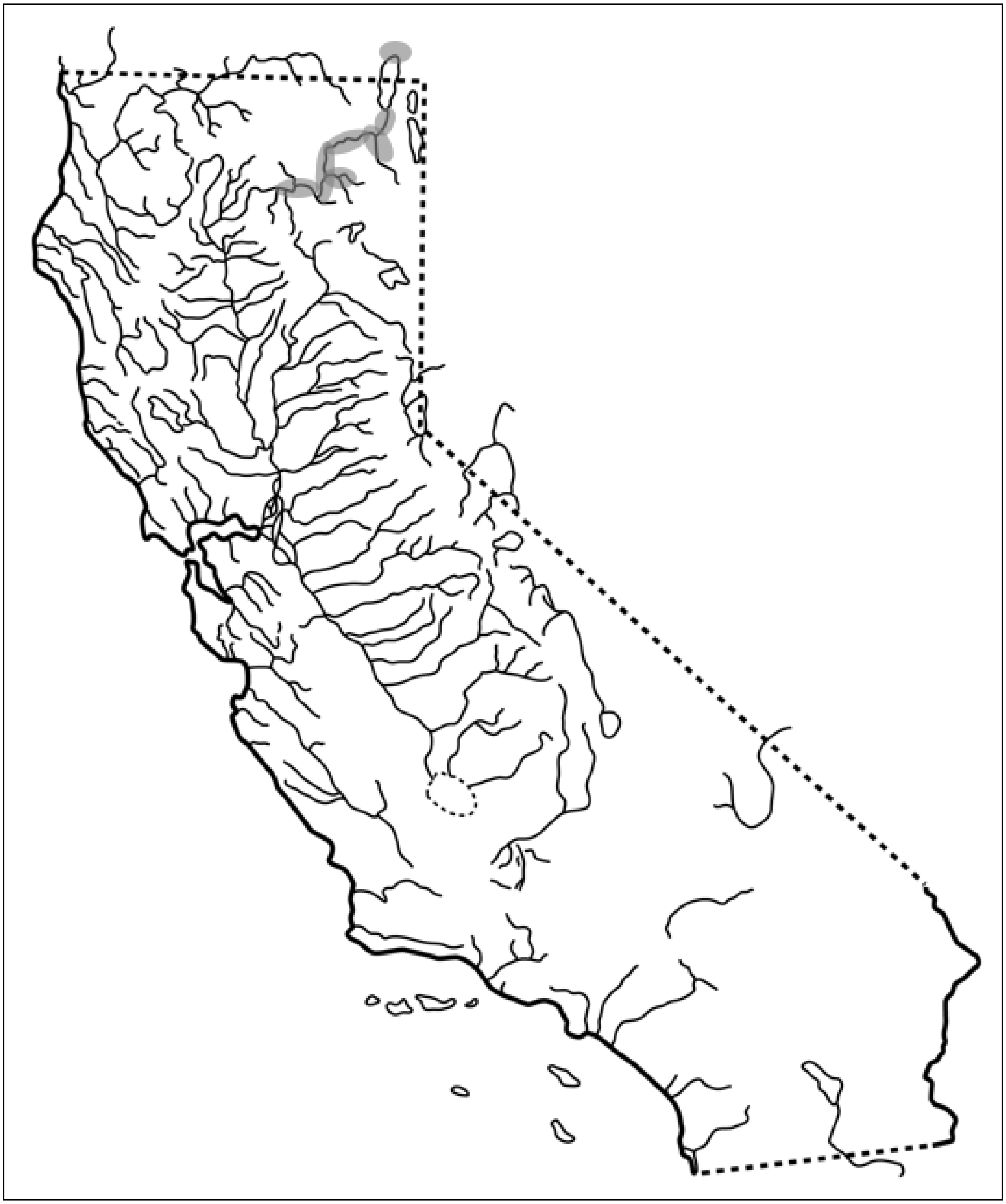

Figure 1. Distribution of northern roach, *Lavinia mitrulus* (Snyder), in California and Oregon.